Objective Evaluation of Color and Consistency in Peach Puree[a, b, c]

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In a study of the factors affecting the color and consistency of purees made from eastern grown freestone peaches, it was desirable to establish objective criteria which could be related to organoleptic evaluations. Development of such quality indices would greatly alleviate the difficulties encountered in maintaining a trained panel of judges and eliminate certain variations due to fatigue in routine subjective testing of a large number of samples.

Measurement of peach color has heretofore been confined mainly to the raw product or processed halves and slices where visual comparison with color charts *(1, 7, 8)* or other visual aids *(2, 9, 10)* were employed. Several objective methods have been reported. Kramer and Haut *(6)* described a spectrophotometric and fluorimetric method for evaluating raw and canned product maturity. Grice *et al. (4)* used the Hunter Color-Difference Meter in describing the browning characteristics of frozen peach slices.

In work dealing with peach puree, Eolkin *(3)* reported a method of comparing color by the use of black and white photography. Hohl *et al. (5)* measured the color of canned and frozen puree with the Maerz and Paul *Dictionary of Color*. Consistency was evaluated with a Bostwick Consistometer.

EXPERIMENTAL

Elberta and Halehaven peaches were pureed in the pilot plant at Geneva during the 1955 and 1956 seasons with the fruit maturity and processing conditions controlled so that a wide range of color and consistency was obtained. Following each season, representative samples were selected for variations in color and consistency and scored on the basis of these factors by a trained panel of 20 judges. A commercial sample prepared from Modesto Midsummer (Clingstone) peaches served as a control in each panel session.

Objective tests. Color and consistency measurements were made at the time of processing and again on a portion of the sample viewed by the panel as follows:

Color. Reflectance measurements, by means of the Hunter Color-Difference Meter, were made on purees in a sample cylinder of optical quality Plexiglas, 2⅝ in. in diameter, filled to a depth of 2 in. A standard reference tile (National Bureau of Standards K. & B. No. 6, Hunter L = 74.7, $a_L = 0.1$ and $b_L = 32.2$) was used in conjunction with the wide aperture and small area illumination settings on the instrument.

Consistency. The Brookfield Synchro Lectric Viscometer and Bostwick Consistometer were used for consistency measurements. For Brookfield measurements a 200-ml. tall form beaker was filled with puree to a depth of 3½ in. and the scale value attained after 10 revolutions of the No. 3 spindle operating at 12 r.p.m. was recorded. Bostwick values were recorded as the distance (in centimeters) of flow which occurred within 10 seconds. All measurements were conducted at 86°F. and run in triplicate.

Taste panel. In an effort to reduce the interaction of color on consistency scores (or vice versa) each attribute was scored individually in separate sessions. Further, when scoring for color the judges were instructed not to stir or taste samples. Color was scored under north daylight with the light intensity maintained at approximately 8 foot candles by means of adjusting the distance between the sample and light source. Light intensity measurements were made with a GE light meter.

Consistency scoring was conducted in a room illuminated with a sodium vapor lamp (589 mμ) so as to disguise sample colors.

Since 60 samples (50 test samples and 10 controls) were scored for color and consistency it was found convenient to use a multiple comparison test wherein each judge scored 5 test samples and one control for color and consistency twice daily. A practice session was used to familiarize judges with score sheets and the values obtained served as a means of selecting judges.

Sampling. Each sample consisted of 6, 8-ounce jars of puree which were randomly selected from lots of 24. The contents were mixed and a 25 per cent aliquot removed for the objective color or consistency measurement. The remainder was presented to the panel.

Color. Samples were viewed in 8-ounce glass babyfood jars placed on a stand at eye level and illuminated from a source located behind the judges. The order of presentation was designed so that the 5 test samples represented a wide range of color. This helped reduce the "downgrading" effect sometimes encountered when all samples are well colored or the "upgrading" when all samples are poorly colored. The 50 test samples were arranged in order of increasing Hunter b_L values since preliminary comparisons of visual scores and the b_L value gave a high correlation (r = 0.78). This array was then divided into 5 equal groups of 10 samples (Table 1).

TABLE 1

Grouping of samples for presentation to color panel

Group number	Hunter b_L range[1]		Number of samples
	Minimum	Maximum	
1	17.5	20.0	10
2	20.5	22.8	10
3	24.2	27.0	10
4	27.2	28.6	10
5	28.7	31.1	10
6[2]	25.5	28.4	10

[1] Based on measurements made at the time of processing.
[2] Controls.

One sample was selected from each group for each panel session. For the first session, the sample having the lowest b_L in each group was selected; in subsequent sessions, the sample having the lowest remaining b_L value, etc. Order of presentation, by group number, was randomized by reference to a table of random numbers.

Consistency. Samples to be scored for consistency were arranged on the basis of increasing Brookfield values. Both

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[b] This report deals with research accomplished in part under a contract with the U. S. Department of Agriculture and authorized by the Research and Marketing Act of 1946. The contract is being supervised by the Eastern Utilization Research and Development Division, ARS.

[c] Journal Paper No. 1089 New York State Agricultural Experiment Station, Cornell University, Geneva, New York.

Brookfield and Bostwick values showed high correlations with visual scores in preliminary tests. Brookfield values were chosen due to the wider range (Brookfield = 68 to 9630, Bostwick = 4.6 to 17.7). This array was then divided into 5 groups of 10 samples as shown in Table 2. The order of presentation was randomized by groups number, the sample having the lowest Brookfield value in each group selected for the first session and the lowest remaining values in each group for subsequent sessions. Each judge received about 30 ml. of puree in coded Petri dishes and was permitted to ladle and taste the samples.

TABLE 2

Grouping of samples for presentation to consistency panel

Group number	Brookfield range[1] (apparent cp.)		Number of samples
	Minimum	Maximum	
1	68	2142	10
2	2192	2922	10
3	3032	4162	10
4	4354	5532	10
5	5568	9630	10
6[2]	6164	6847	10

[1] Based on measurements at the time of processing.
[2] Controls.

Score sheet. The score sheet used for evaluating color and consistency provided spaces for 6 sample codes. For color, the judges were instructed to list the samples in order of increasing desirability of color. For consistency, the samples were listed in order of increasing thickness. Beside the entry space for each sample code was a horizontal scale 10 centimeters long with unnumbered gradations. It was explained that this scale was of continuous nature with the left end representing the poorest color or thinnest consistency and the right end of the scale representing the opposite extreme, depending on the attribute being scored. The relative value of each sample was indicated by the judge placing a check mark over one of the scale gradations.

Tabulation. The distance between the left end of the scale and the judge's check mark was converted to centimeters and represented the numerical score from 0 to 10. The average of 20 scores for color and consistency was then compared with the corresponding objective measurement for each sample.

RESULTS AND DISCUSSION

Color. Figure 1 shows the relationship between actual scores assigned by the panel and scores calculated from the equation:

$$\text{Calculated Score} = -7.36 - 0.22\,(\text{Hunter L}) + 0.45\,(\text{Hunter } a_L) + 0.64\,(\text{Hunter } b_L)$$

In comparing visual color scores with Hunter Color-Difference Meter values, the highest correlation was obtained when L, a_L and b_L values were used in multiple relationship. The coefficient of the multiple correlation for panel score vs. L, a_L and b_L was 0.811.

It was noted that when extreme differences in color saturation were not encountered the Hunter b_L value correlated highly with panel score. This was especially true in the range $b_L = 19$ to 25. With wider color saturations the L (lightness) and a_L (red to green) stimulii apparently play a greater part in assessing color score.

An investigation of the relationship between various combinations of Hunter values with panel color scores gave coefficients of correlation as shown in Table 3: $L = 0.496$, $a_L = 0.702$, $b_L = 0.729$, $a_L/b_L = 0.597$ and $(a_L^2 + b_L^2)^{1/2} = 0.744$. Multiple correlations with two independent variables gave the following coefficients: $L,a_L = 0.718$, $a_L,b_L = 0.785$, and $L,b_L = 0.768$.

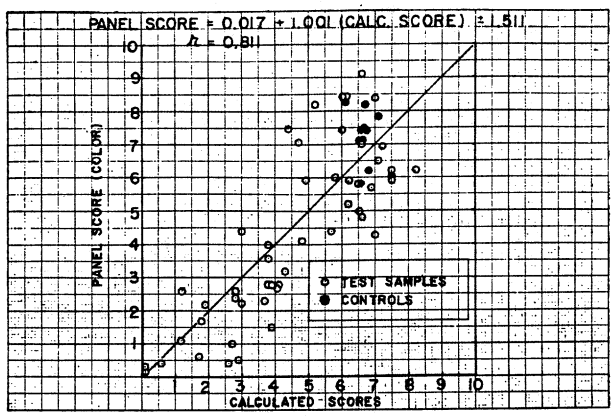

FIGURE 1: Relationship between color panel scores and scores calculated from tristimulus values.

Consistency. The relationship between panel scores for consistency and Brookfield values is illustrated in Figure 2, and with Bostwick values in Figure 3. From these data it is apparent that highly significant correlations were obtained when either instrument was compared with consistency scores as noted in Table 3. With Brookfield values the coefficient was 0.907 and with Bostwick values, —0.956. (Note: low Bostwick values indicate higher consistency). When the two instruments were compared a coefficient of —0.874 was obtained.

It was noted that the commercial control samples, as measured by the Brookfield, generally deviated from linearity. This may have been caused by varietal differences or processing conditions which altered the serum viscosity and/or particle size.

The higher correlation with Bostwick values, in addition to a smaller standard error of estimate, would indicate that this instrument was highly satisfactory for evaluating the consistency of the puree samples studied.

SUMMARY

Objective methods for evaluating the color and consistency of peach puree were investigated. The Hunter Color-Difference Meter was used for measur-

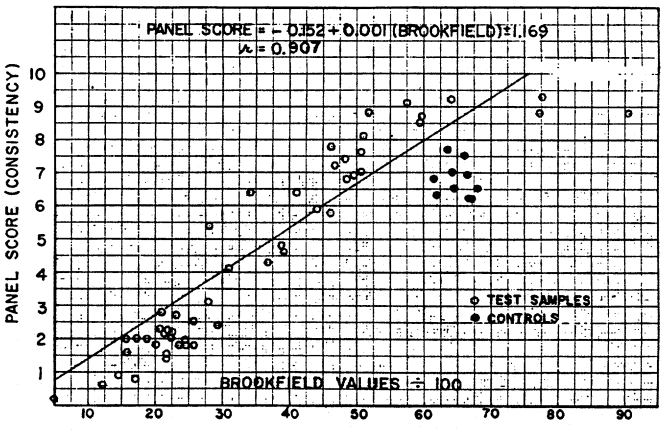

FIGURE 2. Relationship between consistency panel scores and Brookfield values.

Correlations of panel scores with objective measurements of color and consistency

Factors[1]	Regression equation Yc =	Correlation coefficient[2]	Standard error of estimate	95% confidence limit
Color score on Hunter L, a_L and b_L	$-7.36 - 0.22\ L + 0.45\ a_L + 0.64\ b_L$	0.812**	1.511	2.89
Color score on Hunter $a_L + 10$ and b_L	$-10.84 + .495\ (a_L + 10) + 0.3577\ (b_L)$	0.785**	1.606	3.04
Color score on Hunter L and b_L	$5.18 - .24\ (L) + .86\ (b_L)$	0.768**	1.658	3.13
Color score on Hunter $(a_L^2 + b_L^2)^{1/2}$	$-9.08 + 0.55\ X$	0.744**	1.731	3.30
Color score on Hunter b_L	$-9.00 + 0.56\ X$	0.729**	1.774	3.31
Color score on Hunter L and $a_L + 10$	$-10.09 + .09\ (L) + .77\ (a_L + 10)$	0.718**	1.802	3.40
Color score on Hunter $a_L + 10$	$-7.37 + 0.89\ X$	0.702**	1.844	3.42
Color score on Hunter L	$-7.27 + 0.26\ X$	0.496**	2.250	4.23
Consistency score on Brookfield	$-0.15 + 0.001\ X$	0.907**	1.169	2.13
Consistency score on Bostwick	$12.31 - 0.778\ X$	−0.956**	0.799	1.47

[1] For the regression calculation the second named factor is the independent variable (X) in the equation. The first named factor is the dependent variable (Y). The coefficient of (X) is the slope of the curve between the two variables.

[2] Significant at the .01 level.

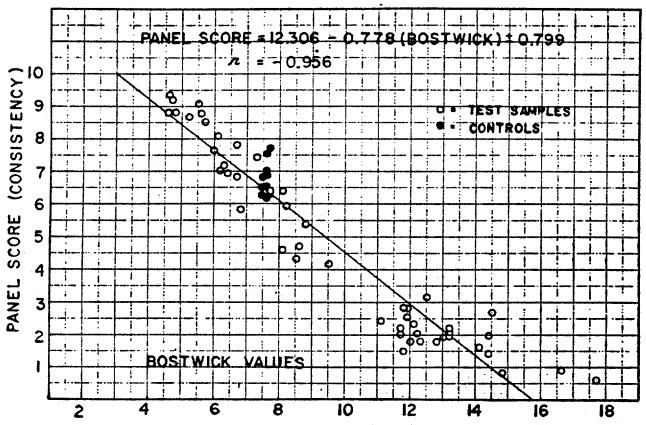

FIGURE 3. Relationship between consistency panel scores and Bostwick values.

ing the color of peach puree. In comparing subjective color scores with Hunter values, the highest correlation was obtained when L, a_L and b_L values were used in multiple relationship ($R = 0.811$). With some sacrifice of accuracy the b_L value alone might serve as a color index where wide variations in saturation are not encountered.

Correlations of subjective scores for consistency with Brookfield SynchroLectric Viscometer and Bostwick Consistometer gave coefficients of 0.907 and —0.956, respectively. In successive measurements on control samples, smaller variance and ease of operation indicated that the Bostwick was highly satisfactory for routine testing.

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